TEACHER BACKGROUND INFORMATION

SOUND

In order to understand sound (and light), we must first understand what waves are.

WHAT ARE WAVES?

Waves are a way to transport energy from one place to another without having to transport any matter. Waves result from some sort of disturbance that sets the particles in the medium in motion causing them to crash into each other. When one particle crashes into another, it transfers its energy to it. During this process, the particles move back and forth or up and down (also called oscillation). These oscillations are what we call waves.

Waves have three basic quantitative properties (Fig.1). **Amplitude** can be thought of as the height or the strength of a wave. **Wavelength** is the length from one peak (or wave front) to another. **Frequency** is a count of how many waves pass any point on their path during a specific amount of time (such as waves per second).

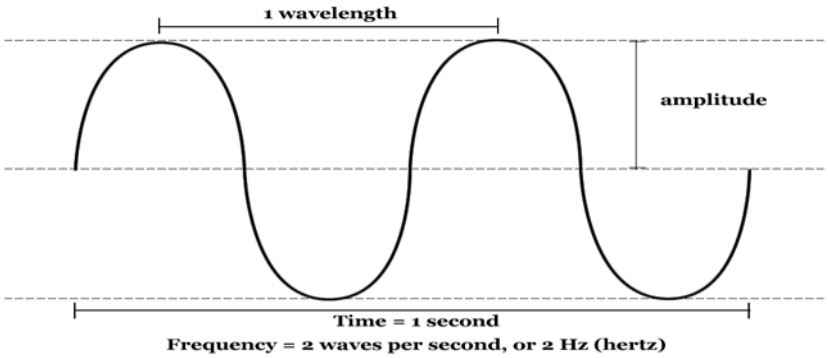

Fig. 1 – Wave properties of a transverse

Waves may be categorized in many ways using observable characteristics. One way to categorize waves is according to their ability to travel through a vacuum (empty space). Mechanical waves require a medium to travel and therefore cannot travel through a vacuum, e.g., sound waves. Electromagnetic waves on the other hand, do not require a medium to travel and can therefore travel though a vacuum, e.g., light waves.

Another way to categorize waves is according to the direction the particles of the wave move in relation to the direction the whole wave is moving. Longitudinal waves contain particles that move parallel to the direction the wave is moving, e.g., sound waves. Transverse waves contain particles the move perpendicular to the direction the wave is moving e.g., light waves. Compare Figure 1 and 2, in Figure 2 the wave is moving from left to right and the particles in figure 2 are colliding with each other and are moving from left to right. However, in Figure 1 the particle is moving from the top to bottom but the wave is moving from left to right. Sound waves are therefore mechanical and longitudinal whereas light waves are electromagnetic and transverse.

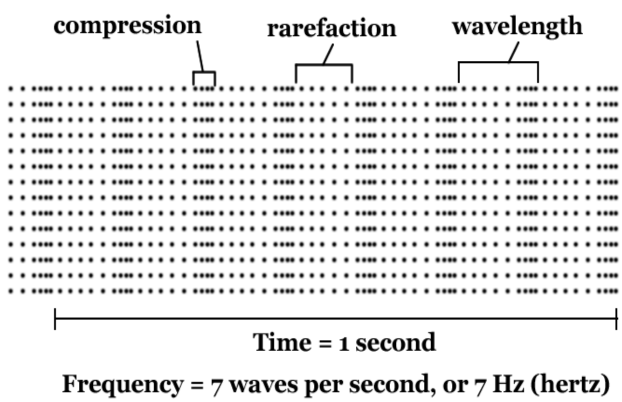

Fig.2 – Compression/Longitudinal

WHAT IS SOUND?

Sound is a form of mechanical energy. We hear sound when energy is transferred from a mechanical source, through a medium, and to our eardrums. When energy is transferred to our eardrums and cause them to vibrate, we "hear" sound. If a tree falls in the forest, it will send a sound wave through the surrounding air whether or not anyone is there to hear it.

An example of sound, as an energy transfer, is when you listen to a radio. The speaker in the radio speaker has a diaphragm that moves back and forth. As it bumps into the air around it (the medium), it causes the air molecules to bump into each other in a uniform direction. Each molecule that gets bumped will bump into another molecule – this is how sound energy is transferred. Eventually molecules will bump into our eardrums, causing them to vibrate, allowing us to hear. The process of energy transfer from one molecule to the next creates a longitudinal wave (see previous section on waves).

The volume, or intensity, of sound is determined by how much energy is put into vibrating the molecules of the medium. If the mechanical source of the sound is weak, such as a radio set on a low volume or the soft tapping on a table, then there won't be very much energy traveling through the medium. The result will be that when it hits our ears, our ear drums will not vibrate very much, and it will not sound loud. On the other hand, if you stand next to a large speaker at a concert, or if you hit a table very hard with your hand or a book, much more energy is transferred into the medium. The result is a very strong motion of our eardrums and a loud sound.

The pitch of the sound we hear is determined by how often, or how quickly, the mechanical source pushes on the medium. The back and forth vibrations of a mechanical source, like a speaker diaphragm or a vibrating string, may push on the medium around it 100, 1000, or even 1000's of times each second. The result is alternating areas that move through the medium that are either compressed together, or spread apart. These are called compressions and rarefactions (see figure 2). These compressed and spread-out areas in the medium make up sound waves. The measurement of how many sound waves are produced during a specific amount of time is known as frequency.

Sound wave frequency is usually measured as waves per second, also known as hertz. When 100 waves per second hit our eardrums (giving a frequency of 100 hertz), we hear a low, rumbling sound. When 10,000 waves hit our eardrums per second, then we hear a high-pitched, piercing sound. Most of what we hear falls somewhere in between. Speech, music, and everything else we commonly hear is the product of the mechanical source of sound varying the loudness and the pitch of sound that it produces.

We have been using air as the medium in our examples, but sound can move through other media (sing. medium) as well. Sound travels through liquids and solids as well as gases. Sound travels fastest through solids and slowest through gases. This is because solids have a very rigid structure, liquids a less rigid structure, and gases the least rigid structure. The rigidity of the structure determines how much it is able to maintain its shape. The more rigid the structure of the medium, the faster the wave will be able to pass through it. This allows longitudinal sound waves to move fastest through solids, slower through liquids and slowest through gases.

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